REMARKS

The Office Action of June 27, 2008, has been carefully reviewed, and in view of the above amendments and the following remarks, reconsideration and allowance of the pending claims are respectfully requested.

In the above Office Action, claims 1, 7-8, 12, 15, 21, 23-26, 33-39 and 41-45 were rejected under 35 U.S.C. §103(a) as being unpatentable over *James et al.* (U.S. Patent No. 6,862,361) in view of *Nevill* (WO 00/78091) and *Guenther* (U.S. Patent No. 6,097,829). Applicant respectfully traverses these rejections.

As set forth above, independent claim 1 has been amended to recite that said one or more elongate members are disposed in low tension so as to maintain said elongate members taut without pre-stressing the same, and that said one or more elongate members comprise tape wound carbon fibers and said stiffening composition comprises an epoxy resin. Applicant respectfully contends that this combination of features is not disclosed or rendered obvious by the cited prior art.

The primary reference relied upon by the Examiner, *James et al.*, is directed to an audio speaker having a diaphragm 22 including a front skin 28 and a rear skin 29, at least a portion of which have a generally conical shape. As acknowledged by the Examiner, *James et al.* do not disclose any type of elongate members wound around the diaphragm.

The secondary reference upon which the Examiner relies, *Nevill*, discloses a stiffened membrane assembly for use as a diaphragm in a speaker. The assembly includes a membrane frame 2 and a multiplicity of tensile members 3 spanning the frame 2 and acting in tension on it. The tensile members comprise flexible material stretched across the frame so as to provide a simple means of generating "very high

tensile forces". In contrast to the claimed invention, the tensile members 3 are maintained in a high degree of tension. As set forth on Page 4, lines 17-19, the membrane frame disclosed in *Nevill* is subjected to a high degree of compression by the tensile forces of the tensile members acting on it. *Nevill* further emphasizes the benefits of pre-stressing the assembly such as by forced displacement tensioning of the tensile members.

Applicant respectfully submits that *Nevill* does not disclose or suggest one or more elongate members disposed in low tension so as to maintain said elongate members taut without pre-stressing the same. *Nevill* specifically advocates for the use of high tension elongate members in order to increase stiffness. The claimed invention does not require the presence of high tension elongate members, unlike *Nevill*, and moreover, tension in the elongate members is not desirable since it may then cause the elongate members to cut into the foam block therebeneath.

Amended claim 1 further recites that said one or more elongate members comprise tape wound carbon fibers and said stiffening composition comprises an epoxy resin. Applicant respectfully contends that *Nevill* fails to disclose the use of tape wound carbon fibers to achieve a high degree of stiffness, but rather, relies upon the high winding tension of the elongate members. Accordingly, it would not be obvious to use tape wound carbon fibers in *Nevill* since the desired level of stiffness is achieved by alternative methodology.

Guenter, a further reference upon which the Examiner relies, also does not disclose or suggest tape wound carbon fibers in an epoxy resin.

Accordingly, in view of the above, Applicant submits that the prior art fails to suggest one or more elongate members disposed in low tension so as to maintain

said elongate members taut without pre-stressing the same and one or more elongate members comprising tape wound carbon fibers in an epoxy resin, as recited in claim 1.

Independent claim 33 as amended above recites one or more elongate members disposed in low tension so as to maintain said elongate members taut without pre-stressing the same. As set forth with respect to claim 1, Applicant respectfully submits that *Nevill* does not disclose or suggest one or more elongate members disposed in <u>low tension</u> so as to maintain said elongate members taut <u>without pre-stressing</u> the same. *Nevill* specifically advocates for the use of high tension elongate members in order to increase stiffness. In contrast, the claimed invention does not require the presence of high tension elongate members, and moreover, tension in the elongate members is not desirable since it may then cause the elongate members to cut into the foam block therebeneath. Accordingly, Applicant submits that claim 33 is patentable over the cited references.

Independent claim 38 is amended as set forth above to recite that the block is bonded to the central tubular member. A multiplicity of turns of one or more elongate members of flexible material stiffened by a stiffening composition is wound tangentially to the central tubular member over the first and second faces so as to stiffen both the central tubular member and said block. The one or more elongate members of flexible material comprise tape wound carbon fibers and said stiffening composition comprises an epoxy resin such that said central tubular member has a high longitudinal stiffness. Dependent claim 46 further recites that the tape wound carbon fibers stiffened by said epoxy resin have a Young's modulus of approximately 300 GPa. Thus, in the claimed invention, the central tubular member achieves a

high longitudinal stiffness through the use of tape wound carbon fibers and an epoxy resin.

The primary reference to *James et al.* includes a central tubular member 37. *James* teaches on page 3, col. 2, lines 4-5, that "A very thin and light member is adequate for carrying this force with negligible distortion".

Nevill discloses an inner hub member 5 in the form of an aluminum cylinder.

Applicant respectfully submits that the prior art fails to suggest a central tubular member having a high longitudinal stiffness as recited in claim 38. As shown on the attached table, a Young's modulus of 300 GPa is indicated as a very high stiffness, whereas aluminum as used in *Nevill* is listed therebelow as having a Young's modulus of 69 GPa. Accordingly, Applicant respectfully contends that claims 38 and 46 are patentable over the cited prior art.

Independent claim 42 recites that the adhesive stiffening composition secures the winding to the block of rigid foam material and secures the block of rigid foam material to the central tubular member. Thus, the stiffening composition is used not only to stiffen the block of foam and the central tubular member, but it also bonds one to the other.

Nevill discloses that the membrane is bonded to the tensile members, but not that the bonding occurs by the stiffening composition within the tensile members themselves. *Nevill* also does not disclose or suggest using the stiffening composition within the tensile members to bond the inner hub member to the membrane. The claimed construction reciting a dual use of the stiffening composition is thus not suggested by *Nevill*. *Guenther* discloses the use of a stiffening composition, but again fails to suggest using the same to both secure the

windings to the block of foam and secure the block of foam to the central tubular member. Accordingly, the cited prior art fails to disclose or suggest the recitations of claim 42.

The dependent claims are patentable at least for the reasons set forth above with regard to the independent claims.

In view of the foregoing remarks, the Examiner is respectfully urged to reconsider and withdraw the outstanding rejections.

In the event there are any questions concerning this response, or the application in general, the Examiner is respectfully urged to telephone the undersigned attorney so that prosecution of the application may be expedited.

Respectfully submitted,

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Young's modulus

From Wikipedia, the free encyclopedia

In solid mechanics, **Young's modulus (E)** is a measure of the stiffness of an isotropic elastic material It is also known as the Young modulus, modulus of elasticity, elastic modulus (though the Young's modulus is actually one of several elastic moduli such as the bulk modulus and the shear modulus) or tensile modulus It is defined as the ratio of the uniaxial stress over the uniaxial strain in the range of stress in which Hooke's Law holds [1] This can be experimentally determined from the slope of a stress-strain curve created during tensile tests conducted on a sample of the material

Young's modulus is named after Thomas Young, the 18th century British scientist However, the concept was developed in 1727 by Leonhard Euler, and the first experiments that used the concept of Young's modulus in its current form were performed by the Italian scientist Giordano Riccati in 1782 — predating Young's work by 25 years [2]

Contents

Units

Young's modulus is the ratio of stress, which has units of pressure, to strain, which is dimensionless; therefore Young's modulus itself has units of pressure A purist might argue that the units are fine if the dimensionless ratio is left in (i e lbs/in^2 over in/in) Carrying the full expression can be helpful for canceling units, in dimensional analysis

The SI unit of modulus of elasticity (E, or less commonly Y) is the pascal; the practical units are megapascals (MPa) or gigapascals (GPa or kN/mm²) In United States customary units, it is expressed as pounds (force) per square inch (psi)

Usage

The Young's modulus allows the behavior of a bar made of an isotropic elastic material to be calculated under tensile or compressive loads For instance, it can be used to predict the amount a wire will extend under tension or buckle under compression Some calculations also require the use of other material properties, such as the shear modulus, density, or Poisson's ratio.

Linear *versus* non-linear

For many materials, Young's modulus is essentially constant over a range of strains Such materials are called linear, and are said to obey Hooke's law Examples of linear materials include steel, carbon fiber, and glass. Rubber and soils (except at very small strains) are non-linear materials.

Directional materials

Young's modulus is not always the same in all orientations of a material Most metals and ceramics, along with many other materials, are isotropic: Their mechanical properties *are* the same in all orientations However, metals and ceramics can be treated with certain impurities, and metals can be mechanically 'worked.' to make their grain structures directional These materials then become anisotropic, and Young's modulus will change depending on which direction the force is applied from Anisotropy can be seen in many composites as well For example, carbon fiber has a much higher Young's modulus (is much stiffer) when force is loaded parallel to the fibers (along the grain), and is an example of a material with transverse isotropy Other such materials include wood and reinforced concrete Engineers can use this directional phenomenon to their advantage in creating various structures in our environment

Calculation

Young's modulus, E, can be calculated by dividing the tensile stress by the tensile strain:

$$E \equiv \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{\sigma}{\varepsilon} = \frac{F/A_0}{\Delta L/L_0} = \frac{FL_0}{A_0 \Delta L}$$

where

E is the Young's modulus (modulus of elasticity)
F is the force applied to the object;
A_0 is the original cross-sectional area through which the force is applied;
ΔL is the amount by which the length of the object changes;
L_0 is the original length of the object

Force exerted by stretched or compressed material

The Young's modulus of a material can be used to calculate the force it exerts under a specific strain.

$$F = \frac{EA_0 \Delta L}{L_0}$$

where F is the force exerted by the material when compressed or stretched by ΔL.

From this formula can be derived Hooke's law, which describes the stiffness of an ideal spring:

$$F = \left(\frac{EA_0}{L_0}\right)\Delta L = kx$$

where

$$k = \frac{EA_0}{L_0}$$
$$x = \Delta L.$$

Elastic potential energy

The elastic potential energy stored is given by the integral of this expression with respect to L:

$$U_e = \int \frac{EA_0\Delta L}{L_0}\,dL = \frac{EA_0}{L_0}\int \Delta L\,dL = \frac{EA_0\Delta L^2}{2L_0}$$

where U_e is the elastic potential energy

The elastic potential energy per unit volume is given by:

$$\frac{U_e}{A_0L_0} = \frac{E\Delta L^2}{2L_0^2} = \frac{1}{2}E\varepsilon^2,\ \text{where } \varepsilon = \frac{\Delta L}{L_0} \text{ is the strain in the material.}$$

This formula can also be expressed as the integral of Hooke's law:

$$U_e = \int kx\,dx = \frac{1}{2}kx^2.$$

Relation among elastic constants

For homogeneous isotropic materials simple relations exist between elastic constants (Young's modulus E, shear modulus G, bulk modulus K, and Poisson's ratio ν) that allow calculating them all as long as two are known:

$$E = 2G(1+\nu) = 3K(1-2\nu).$$

Approximate values

Young's modulus can vary somewhat due to differences in sample composition and test method. The values here are approximate.

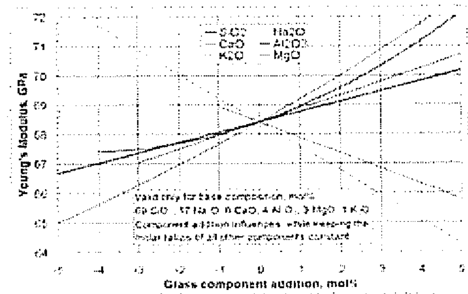
Approximate Young's moduli of various solids

Material	Young's modulus (E) in GPa	Young's modulus (E) in lbf/in² (psi)
Rubber (small strain)	0.01-0.1	1,500-15,000
PTFE (Teflon)	0.5	75,000
Low density polyethylene	0.2	30,000
HDPE	1.379	200,000
Polypropylene	1.5-2	217,000-290,000
Bacteriophage capsids	1-3	150,000-435,000
Polyethylene terephthalate	2-2.5 OR 2.8-3.1	290,000-360,000
Polystyrene	3-3.5	435,000-505,000
Nylon	2-4	290,000-580,000
MDF (wood composite)	3.654	530,000
Pine wood (along grain)	8.963	1,300,000
Oak wood (along grain)	11	1,600,000
High-strength concrete (under compression)	30-100	4,350,000
Magnesium metal (Mg)	45	6,500,000
Aluminium alloy	69	10,000,000
Glass (see also diagram below table)	65-90	9,400,000-13,000,000
Brass and bronze	103-124	17,000,000
Titanium (Ti)	105-120	15,000,000-17,500,000
Copper (Cu)	110-130	16,000,000-19,000,000
Carbon fiber reinforced plastic (50/50 fibre/matrix, unidirectional, along grain)	125-150	18,000,000 - 22,000,000
Wrought iron and steel	190-210	30,000,000
Beryllium (Be)	287	41,500,000
Tungsten (W)	400-410	58,000,000-59,500,000
Silicon carbide (SiC)	450	65,000,000
Osmium (Os)[3]	550	79,800,000
Tungsten carbide (WC)	450-650	65,000,000-94,000,000
Single carbon nanotube [1]	1,000+	145,000,000+
Diamond (C)	1220([4])	150,000,000-175,000,000

See also

- Deflection

- Deformation
- Hardness
- Hooke's law
- Shear modulus
- Impulse excitation technique
- Strain
- Stress
- Toughness
- Yield (engineering)
- List of materials properties



Influences of selected glass component additions on Young's modulus of a specific base glass ([5])

References

1. ^ International Union of Pure and Applied Chemistry "modulus of elasticity (Young's modulus), E" *Compendium of Chemical Terminology* Internet edition.
2. ^ *The Rational Mechanics of Flexible or Elastic Bodies. 1638-1788*: Introduction to Leonhardi Euleri Opera Omnia, vol X and XI, Seriei Secundae Orell Fussli
3. ^ http://www.engineeringtoolbox.com/young-modulus-d_417.html
4. ^ ['Synthetic Diamond - Emerging CVD Science and Technology' Spear and Dismukes. Wiley, NY. 1994]
5. ^ Glassproperties.com

External links

- Matweb: free database of engineering properties for over 63.000 materials

Conversion formulas [hide]

Homogeneous isotropic linear elastic materials have their elastic properties uniquely determined by any two moduli among these: thus given any two, any other of the elastic moduli can be calculated according to these formulas

	(λ, μ)	(E, μ)	(K, λ)	(K, μ)	(λ, ν)	(μ, ν)	(E, ν)	(K, ν)	(K, E)	(M, μ)
$K=$	$\lambda+\frac{2\mu}{3}$	$\frac{E\mu}{3(3\mu-E)}$			$\lambda\frac{1+\nu}{3\nu}$	$\frac{2\mu(1+\nu)}{3(1-2\nu)}$	$\frac{E}{3(1-2\nu)}$			$M-\frac{4\mu}{3}$
$E=$	$\mu\frac{3\lambda+2\mu}{\lambda+\mu}$		$9K\frac{K-\lambda}{3K-\lambda}$	$\frac{9K\mu}{3K+\mu}$	$\frac{\lambda(1+\nu)(1-2\nu)}{\nu}$	$2\mu(1+\nu)$		$3K(1-2\nu)$		$\mu\frac{3M-4\mu}{M-\mu}$
$\lambda=$		$\mu\frac{E-2\mu}{3\mu-E}$		$K-\frac{2\mu}{3}$		$\frac{2\mu\nu}{1-2\nu}$	$\frac{E\nu}{(1+\nu)(1-2\nu)}$	$\frac{3K\nu}{1+\nu}$	$\frac{3K(3K-E)}{9K-E}$	$M-2\mu$
$\mu=$			$3\frac{K-\lambda}{2}$		$\lambda\frac{1-2\nu}{2\nu}$		$\frac{E}{2+2\nu}$	$3K\frac{1-2\nu}{2+2\nu}$	$\frac{3KE}{9K-E}$	
$\nu=$	$\frac{\lambda}{2(\lambda+\mu)}$	$\frac{E}{2\mu}-1$	$\frac{\lambda}{3K-\lambda}$	$\frac{3K-2\mu}{2(3K+\mu)}$					$\frac{3K-E}{6K}$	$\frac{M-2\mu}{2M-2\mu}$
$M=$	$\lambda+2\mu$	$\mu\frac{4\mu-E}{3\mu-E}$	$3K-2\lambda$	$K+\frac{4\mu}{3}$	$\lambda\frac{1-\nu}{\nu}$	$\mu\frac{2-2\nu}{1-2\nu}$	$E\frac{1-\nu}{(1+\nu)(1-2\nu)}$	$3K\frac{1-\nu}{1+\nu}$	$3K\frac{3K+E}{9K-E}$	

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